Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

REVIEWS

A New Attack on Problems of Ecology

With the publication of the second book[1] in a series of three on the ecology of roots, it becomes evident that plant studies of the future are going to be more thorough as the result of Dr. Weaver's contributions. The importance of the study of the root systems of plants needs no defense here. It is work which seems to have waited until a scholar with the requisite skill and patience to assume a task so laborious as that of dissecting root systems should step forward. One glance at a photograph of a trench in which the work of root dissection is going on convinces the reader of the mighty efforts that are being put forward to obtain fresh facts on the life habits of plants. In the pre-Theophrastan days Dr. Weaver would have been made a high priest of the ancient and honorable order of the Rhizotomi. While this high distinction is not open to him, yet 20th century distinctions of more certain merit will reward his industry. For his is the accomplishment of starting pioneer work that will help us see living plant associations whole.

The first book on this subject, "The Ecological Relations of Roots,"[2] has been viewed in a number of places, perhaps most satisfactorily by Professor Tansley in the JOURNAL OF ECOLOGY for June, 1920. For it is admittedly difficult to treat with dexterity a work in which there appears, because of the nature of the subject matter, so much descriptive data. The descriptions are necessary to an understanding of the material, and if these preliminary books are to serve as a basis of study for future work, the descriptions err in the direction of being too short, rather than too long. Yet it is to be hoped that within the next few years some summaries of the ecology of roots will be forthcoming.

It is plain, however, that Weaver's researches of the past several years have qualified him especially to undertake the task of describing root systems of plants as they appear when actually functioning. Therefore, this work should not be interrupted until a sufficient number of descriptions have been made. More than 1500 root systems have been examined already, "almost in their entirety."

The lucky chance to see some of the root dissections mounted in the Botanical Laboratory of the University of Nebraska came to the reviewer last summer. Any momentary doubt as to the validity of Professor Weaver's results is at once cleared away by the remembrance of those dissections. There is, of course, the discrepancy with Shantz's work.[3] Shantz, writing of *Bulbilis dactyloides*, buffalo grass, and *Bouteloua gracilis*, grama grass, stated that almost the entire root system is limited to the first 18 inches of soil. Weaver, on the other hand, found that the roots are much deper than that. The average working depth for buffalo grass in a variety of habitats he discovers to be more than 4 feet. The maximum depth of penetration for this species is reported as 7.2 feet at Ardmore, South Dakota, in the *Stipa-Bouteloua* association. "In addition to having a splendid absorbing system near the surface," Professor Weaver states, "both of these xerophytic species (*Bulbilis* and *Bouteloua*) are also deeply rooted."

---

[1] Weaver, John E., 1920, "Root Development in the Grassland Formation," Carnegie Inst. Wash. Pub. 292.

[2] Weaver, John E., 1919, "The Ecological Relations of Roots," Carnegie Inst. Wash. Pub. 286.

The reader is likely to say that the book is excellent but imperfect. Weaver uses, and is "in hearty agreement" with, the disturbing classification of the grasslands outlined by Clements.[4] Proceeding from the more xerophytic to the less xerophytic groups, there are three associations, the short grass plains, the mixed prairie and the true prairie. The plains association of *Bulbilis-Bouteloua* is understandable and before 1920 had won general approval. In fact, the identification of this association was crystallized when Schimper's book appeared. The mixed prairie, described as containing "the dominants of both prairie and plain," a *Stipa-Bouteloua* association, was probably proposed tentatively. It sounds as though it might be an admission of inability to cope with the problem of classification for the time being, until certain developments in the vegetation become more manifest. On this ground, the *Stipa-Bouteloua* association deserves a somewhat sympathetic treatment at the hands of ecologists. The third, the least xerophytic of the grassland communities, is called the "true" prairie, a *Stipa-Koeleria* association.

The reader may at once ask, "What about the prairie that became the great corn belt of the United States?" He then will be referred rather vaguely to the "subclimax" prairie. For the "true" prairie is described as a "distinct belt between the subclimax prairie on the east and the mixed prairie on the west, reaching from Manitoba to Oklahoma." If the *Stipa-Koeleria* prairie is the true prairie, then by implication, the *Andropogon furcatus* prairies, which were the ones first seen, are the false prairies. It is most disturbing to read that *Stipa* and *Koeleria* are the dominants of the true prairie. Such a classification overlooks *Andropogon furcatus* as the important sod forming grass of the least xerophytic of the grassland communities. It also omits the changes man has wrought in the native vegetation. For the *Andropogon furcatus* grasslands have been most destroyed in the interests of agriculture. While the prairie relicts are now limited, mainly, to hedge rows, fence rows, railway right-of-way, and similar restricted havens, their extent is yet fresh in the memories of a few farmers still living. We have the pioneers' written records; furthermore, we are still able to map out the location of prairies on the basis of soil fertility with a fair degree of exactness. It, therefore, seems inconsiderate for an ecologist, who desires, as all of us do, to place agriculture on an ecological basis, to call our most productive grassland areas the "subclimax" prairie. It is not at all clear that the *Andropogon furcatus* prairies, "with their greater rainfall, denser sod, and more mesophytic and taller dominants, will be replaced by scrub or woodland wherever fire, cultivation or grazing does, not prevent" (Weaver, 1919; Clements, 1920).

---

[3] Shantz, H. L., 1911, "Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area," Bureau of Plant Industry, Bull. 201.

[4] Clements, F. E., 1920, "Plant Indicators," Carnegie Inst. Wash. Pub. 290.

It is not my purpose here to give the evidence *pro* and *con* on the prairie. It is sufficient to say that at the Chicago meetings the reviewer met and talked with ten prominent students of the grasslands of North America. That there would be divergence of opinion goes without saying, but there seemed to be a general unified agreement on the point of the *Andropogon furcatus* prairie being a distinctive formation. There is forest invasion in some places, notably along streams. Yet that is no more an excuse for saying that it "will be replaced by scrub or woodland," than there is valid reason for saying that the hills of Eastern Ohio are a potential Northeastern evergreen forest because *Pinus strobus* is there; or that these hills are potentially southeastern forest because *Pinus echinata, P. rigida,* and *P. virginiana* are there.

Another interesting point of the discussion hinges on the prominence now given to the *Stipa-Koeleria* association. Twenty years ago in Kansas records made by Professor Hitchcock, the distinguished student of grasses, failed to show the frequency of distribution that it now has. At that time, it was suggested that its increase was a consequence of the greater grazing practiced since man's advent. As keen an observer as Professor Schaffner, who grew up in Kansas, is quite positive in his statement that the *Andropogon* association and not the *Stipa-Koeleria* association is the prairie. It appears that Clements disagrees with most plant ecologists because, first, he believes the prairie (*Andropogon furcatus*), to be a subclimax association, due to fires; second, he has departed from the well founded practice of naming an association from its dominant species and to have chosen species that have a wide distribution in a variety of habitats (N. B. *Stipa-Koeleria*); and that he further has not made due allowance for the changes in the vegetation since the white man's advent.

This classification then is the chief fault of the book, and, with the reader's attention thus directed to it, it will no longer bother him to read of the "true" prairie containing as the dominants "*Andropogon scoparius, Stipa spartea, Agropyrum glaucum, Stipa comata, Andropogon furcatus,* and *Koeleria cristata*." He may leaf back and forth through the chapters and rearrange the discussion of the root systems of these plants to suit his convenience and needs.

The most instructive part of the book and the part that will doubtless be most widely read is at the end. The last two chapters are entitled, "The Root Systems of Cereals" and "Root Development of Crop-plant Ecads."

In the former chapter the importance of water as a limiting factor in the agriculture is clearly revealed. Soil salts are never the master factor in crop production in these dry grasslands. This is evident when the growth of the cereals in each of the three main grassland associations is compared. In the plains the heights of the tops, the depth of root penetration and the average working depth of the roots are all less than in either of the other two less xerophytic associations. There is an orderly and progressive increase in growth with an increase in water content of the soil. And as Doctor Weaver points out, a direct study of the rainfall, the values of the mean annual precipitation and that of the annual precipitation for the year of the experiment, is not of much help in forecasting yields. The uncertainty of distribution and the high evaporation and transpiration rates in the xerophytic grasslands negative all attempts at correlation of rainfall and crop yields. In this connection, the picture of the soil as a reservoir from which plants draw their water is useful. The date of filling the reservoir is of no importance. The only thing that counts is the supply on hand at the time when plant is most in need. "The smaller development of both aerial and underground portions of crop plants in mixed prairies [the *Stipa-Bouteloua* association], and their still poorer development in the short grass plains is to be expected, but the correlation has not heretofore been worked out. Shantz (1911) has given certain correlations between root development of native species and water content as affected by soil type in Eastern Colorado, but his findings of root depths in short grass lands appear quite erroneous. The close correlation between the poorer development of root and shoot of a given crop as less favorable growth conditions occur is marked. Such a relation has also been found for *Agropyrum glaucum* (p. 78). These results greatly increase the exactness of the use of natural vegetation as indicators and throw much light upon agricultural practice."

In the chapter on "Root Development of Crop-plant Ecads"[5] are described roots of crop plants grown under two sets of environmental conditions. In one set the plats were situated in lowland, at the edge of the flood plain of a small stream. The other was approximately one mile distant and 80 feet higher on a broad level hilltop of silt-loam, adjoining a typical upland prairie area. Weaver's summary of the data on root development in

[5] In Clement's (1905) "Research Methods in Ecology" (p. 316) Ecad is defined as "a habitat form due to origin by adaptation." Weaver's use of "ecad" has not made the chapter title any more clear.

the two sets of plats is given in Table 16, page 139. He shows that with all plants tested the roots were longer in proportion to the height of tops on the upland than on the lowland.

The discussion of these results in Weaver's last chapter is clear and forceful; the work is fundamental to our study of plant associations and needs to be consulted by all ecologists. Here is an idea worthy of trial: "Using again the natural vegetation as the indicator of conditions for agricultural practice, the rotation of short rooted and densely rooted crops with those of longer and more spreading root systems should prove advantageous, if, indeed, under intensive agriculture, two such crops might not be grown on the same area at the same time."

Weaver's own evaluation of the years of laborious research is succinctly as follows: "A knowledge of the development, position, and competition of roots is indispensable in explaining the phenomena of succession. Since root position so clearly reflects the moisture conditions of the soil, especially when interpreted in its community relations, a study of the root habits of plants greatly increases our knowledge of the value of various species in indicating lands of agricultural or non-agricultural value, and aids us in selecting the kind of crop to be most profitably grown, as well as in determining the proper methods of tillage. A study of the root development of crop plants in the various plant associations renders more accurate our interpretation of the indicator significance of the natural vegetation and points the way to a solution of some of the most fundamental problems of plant ecology in its manifold relations to crop production."

A. E. Waller